

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

SECTION 16620

EMERGENCY GENERATOR

PART 1 - GENERAL REQUIREMENTS

1.1 Related Documents

- A. All sections of Division 1.
- B. Examine all drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section. Work shall be coordinated with other trades prior to installation to prevent interference and relocations.

1.2 Related Documents

- A. The general provisions of the Contract, including General and Supplementary Conditions and all Sections of Division 1, apply to the work of this section.
- B. Examine all Drawings and all other sections of the specifications for requirements therein affecting the work of this section. Sequence, coordinate and integrate the various elements of electrical work so that the electrical system will perform as indicated and be in harmony with the other systems in the building. The Engineer will not supervise the coordination, which is the exclusive responsibility of the Contractor.
- C. In all instances where an item is referred to in the singular number in these specifications or on the Drawings, it shall be understood that the reference shall apply to as many such item as are necessary to complete the work.

1.3 Scope of Work

- A. Provide all labor, materials, equipment and incidentals required to furnish and install complete and fully operating electrical systems as shown on the Drawings and specified herein, but not limited to, the following:
 - 1. Power and control wiring for new air conditioning system.
 - 2. New 60 KW emergency generator with remote radiator and new transfer switch.
 - 3. Power Distribution: Feeders, sub-feeders and over-current protection.
 - 4. Panelboards, circuit breakers, disconnect switches and fuses.
 - 5. Branch circuits to all equipment, including equipment provided by other sections.
 - 6. Removal and relocation of existing work.
 - 7. Wiring devices and outlets.
 - 8. Motor branch circuits and 120 volt control wiring.
 - 9. Grounding and bonding.
 - 10. Installation of materials furnished by others where indicated.
 - 11. Temporary power and lighting for construction.

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

1.4 Temporary Power and Light

- A. Provide a system of temporary power and light for each project area as required. Provide ground fault protection per N.E.C.
- B. When no longer needed for construction work, remove electrical temporary facilities. Repair and restore work damaged by installation and operation of electrical temporary facilities. Clean and restore permanent electrical systems which may have been used to provide temporary services, to the condition of new and unused work except for normal wear. Electrical work installed as temporary facilities shall, upon removal, remain the property of the Installer.
- C. Existing electrical system may be used for temporary power to the extent permitted by the Owner, within existing capacity. provide temporary circuit extensions from sources and locations directed by the Owner.

1.5 Codes, Permits and Fees

- A. All electrical work and installation shall comply with applicable provisions of the National Electrical Code NFPA-70, BOCA Basic Building Code with Supplements, U.L, ANSI, IPCEA, NEMA, NFPA, and State and Local Codes, Laws and Regulations, latest editions.
- B. Give all notices, file all plans, obtain all permits and licenses, pay all fees and obtain all necessary Certificates of Inspection and Approvals from authorities having jurisdiction and present to Owner.

1.6 Submittals

- A. Comply with the requirements of the General Conditions as applicable. Provide five (5) copies of all required submittals.
- B. Uniformity, unless otherwise specified, equipment or materials of same type or classification shall be used for same purposes and shall be product of same manufacturer.
- C. Provide submittals for the following products and/or systems:
 - 1. Disconnect switches and fuses
 - 2. Panelboards and circuit breakers
 - 3. Motor starters and controllers
 - 4. Wiring devices
 - 5. Stand-by generator with all accessories
 - 6. Transfer switch with all accessories
 - 7. Remote radiator with hot well, pump, piping, valves and all accessories.

1.7 Access Panels

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

- A. Provide access panels when switches, devices, pull boxes, valves and similar items of mechanical and electrical work are located behind finished walls, ceilings and floor construction. Minimum size to be 12" x 12". Equal to Micor or Zurn Industries, hinged door. Fire Rated, if required.
- B. Comply with manufacturer's written instructions and recommendations for the installation of access plate units: including setting, coordinate with other work, anchoring, cleaning, adjusting and protection during subsequent work. Remove and replace units which are damaged or do not provide proper access to work as required.

1.8 Equipment Identification

- A. Provide cable/conductor identification on each cable and conductors in each box/enclosure/cabinet where the wires of more one circuit or communications/signal system are present, except where another form of identification (such as color-coding conductors) is provided. Match identification with marking system used in panelboards.
- B. Provide cable/conductor identification at each box/enclosure/cabinet by labeling the cover with permanent marker, of contrasting color, indicating panel and circuit number contained within. Match identification with marking system used in panelboards.
- C. Wherever reasonably required to ensure safe and efficient operation and maintenance of the electrical systems, and electrically connected mechanical systems and equipment, including prevention of misuse, provide plastic operational or warning signs or similar equivalent identification, instruction or warnings.
- D. Provide an engraved plastic-laminate sign on each major piece of electrical equipment in the building; including the central or master unit of each electrical system and communication/signal systems, unless the unit is specified with its own self-explanatory identification. Provide 1/2" high lettering on 1-1/2" high sign, engraved with engraver's standard letter style, white with black core (letter color), punched for mechanical fastening. - Thickness 1/8". Where identification is to be applied to surfaces which require finish, install identification after completion of painting.
- E. Comply with governing regulations and the requests of governing authorities for the identification of electrical work.

1.9 Test, Adjustments, Cleaning and Lubrication

- A. Coordinate test runs of electrical systems with test runs of equipment served thereby (heating, air conditioning, plumbing, etc.). Check each item in each system to determine that it is set for proper operation. With Owner's Representative and Engineer present, operate each system in a test run of appropriate duration to demonstrate compliance with performance requirements. During or following test runs, make final corrections where possible, including noise and vibration reductions, elimination of hazards, better response of controls, signals and alarms, and similar system performance improvements. Provide testing or inspection devices as may be reasonably requested for Engineer's observation of actual system performances. Demonstrate

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

that controls and items requiring service or maintenance are accessible.

- B. After final performance test run of each electrical system, clean system both externally and internally. Comply with manufacturer's instructions for lubrication of both power and hand operated equipment, and remove excess lubrication. Touch-up minor damage to equipment finishes.
- C. Refer to specification of materials in Part 2 - Products for additional testing requirements.

1.10 Product Delivery, Storage and Handling

- A. Deliver products individually wrapped in factory-fabricated containers.
- B. Handle products carefully to avoid damage to material components, enclosure and finish. Do not install damaged products, remove from project site.
- C. Store products in a clean, dry space. Protect products from dirt, fumes, water and physical damage.

1.11 Installation - General

- A. Install all electrical materials in accordance with the manufacturer's written instructions, and applicable requirements of National, State and Local Standards, Codes and Laws.
- B. Prior to energizing, test all equipment for proper continuity of circuits, insulation resistance and absence of shorts and grounds.
- C. Provide supports for all equipment in accordance with code requirements and manufacturer's instructions. Supports will be rated for the maximum load plus 50%. All supports shall be installed in a neat and workmanlike manner.
- D. All equipment shall be installed plumb in both horizontal and vertical directions and shall have a neat and finished appearance.

1.12 Removals

- A. Except where specifically noted otherwise, all existing fixtures, wiring devices, outlets, branch circuits, panelboards, and wiring shall remain. Remove existing work as specifically indicated on the Drawings or as necessary to install new work.
- B. All removed materials, not re-used in the work, shall be properly disposed of, off the project site, except for lighting fixtures, lamps, disconnect switches, circuit breakers, generator and, transfer switch, which shall be returned to the Owner. Move such materials to an on-site storage location as directed by the Owner.
- C. Where any branch circuit or system wiring, indicated to be removed, serves equipment outside of the work area, extend and reconnect the wiring as required so that all equipment remains

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

fully operational.

- D. Verify extent of removals prior to Bidding. Before performing any removals, verify with Owner that such work is appropriate and its area of service is confined to the project space.

1.13 Reuse of Existing Materials

- A. In general, existing materials to be removed shall not be re-used except as specifically indicated on the Drawings and as follows:
 - 1. The existing generator and transfer switch shall remain in service until superseded by fully operational new system.
- B. Existing branch circuit wiring may be reused as indicated and where the following requirements are complied with:
 - 1. Wiring is suitable for the circuit requirements on the Drawings.
 - 2. Wiring complies with all current requirements of the N.E.C. or is altered as necessary to comply with the Code.
- C. Existing materials to be re-used shall be removed, carefully stored, cleaned and reinstalled at the locations indicated on the Drawings. Existing materials to be re-used or remain that are broken during the Work shall be replaced with new materials of equivalent quality at no additional cost to the Owner.

1.14 Interruption of Services

- A. Where the Work requires interruption of service, shutdown services at night or at such times as directed by the Engineer that will cause the least interference with the building. Arrange to work continuously, including over time if necessary, to ensure service interruptions are as short as possible. After interruptions verify that all is operating normally.

1.15 Special Wiring Requirements

- A. The work requires several special applications of branch wiring and disconnecting means. In particular, but not limited to, the Contractor shall comply with the following:
 - 1. Emergency Power Systems N.E.C.-700, 701, NFPA-99, 110
 - 2. L.P Gas Fuel Supply NFPA-54
 - 3. Sealing Underground Conduits N.E.C.-300-5 & 6
 - 4. Penetrations of Fire Walls N.E.C.-300-21

PART 2 - PRODUCTS

2.1 General Materials

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

- A. General materials shall be the manufacturer and model number indicated on the Drawings and as specified herein, or equal.

2.2 Conductors

- A. Conductors shall be copper, 600 volt insulation, solid through #10 AWG, stranded above, insulation Types THWN, XHHW or THHN.
- B. Provide type THHN insulated conductors listed "gasoline and oil resistant" for all wiring at the generator.
- C. Provide conductors equal to Southwire, General Wire and Cable, or Rome.

2.3 Connectors

- A. At each splice, tap or termination provide a complete assembly of lugs, terminations, connectors and insulation as required. Use pressure type connectors and set screw lugs for copper connections. Connectors and terminations as manufactured by Brundy, 3-M, IlSCO or equal.

2.4 Conduit and Fittings

- A. Conduit shall be galvanized rigid steel, intermediate metal, EMT, flexible metal, or liquid-tight flexible, conduit equal to Jones and Laughlin, Allied or Anaconda.
- B. Fittings shall be threaded for rigid conduit, threaded or set-screw for I.M.C., set-screw or compression for EMT, set-screw for flexible and sealed compression for liquid tight. Fittings shall be of the same material as the conduit.
- C. Provide locknuts, bushings, conduit bodies, expansion fittings, straps and seals as required to complete conduit systems.

2.5 Boxes and Fittings

- A. Provide outlet, pull and junction boxes as required for each application. Boxes shall be minimum 1-1/2" deep. Interior boxes shall be standard stamped galvanized steel equal to Raco or Steel City. Exterior boxes shall be cast type with threaded hubs and gasketed weatherproof covers equal to Hubbell or Bell.

2.6 Supporting Devices

- A. Provide hangers, staples, straps, etc., by Thomas and Betts or equal. Provide channel type supports, equal to unistrut, as required.
- B. Chain, wire or perforated strap shall not be used for supporting devices.

2.7 Wireway

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

- A. Provide U.L. Listed lay-in wireway constructed of code gauge steel, equal to General Electric.
- B. Provide wireway fittings as indicated on the Drawings of size and type to fit existing wireway.

2.8 Disconnect Switches and Fuses

- A. Provide manufacturers standard disconnect switches equal U.L. general duty switches in NEMA 1 or 3R enclosure constructed of code gauge steel. Fused units shall be equipped with dual element Class RK5 fuses for motor circuits, Class RK1 fuses for feeders. Switches shall have a minimum withstand rating of 100,000 amperes, RMS, symmetrical with rejection type fuse clips.

2.9 Panelboards and Circuit Breakers

- A. Provide panelboards as scheduled herein. Panelboards shall be dead front safety type, aluminum bus bars, CU/AL connectors, full size neutral bus, and ground bus. Cabinets shall be constructed of code gauge steel, NEMA Type 1, surface or flush mounted as indicated with front door and trim as required. Panel cover shall be flush front trim, (Door-in-door). Equip each panelboard with typed directory.
- B. Circuit breakers shall be molded case type, thermal and magnetic trip units, trip-free operation, bolt-on type with pressure lugs for load connections, 10,000 amperes, RMS, symmetrical minimum interrupting capacity or higher as scheduled.
- C. Circuit breakers for existing panelboards and switchboards shall be provided as required to fit existing equipment, with minimum rating of 42,000 A.I.C. Existing equipment is Square D using KA and FA frame circuit breakers.

2.10 Motor Starters and Contactors

- A. General: All motor starting and control equipment shall meet the following requirements and shall include all necessary auxiliary contacts, devices required to operate, control and protect the motor under all conditions.
- B. Manual Starters: Toggle switch for motors under manual control only or hand-off-automatic selector switch for motors with automatic contacts, devices required to operate, control and protect the motor under all conditions.
- C. Motor Disconnect Switch: Toggle switch type without overload protection, 1, 2 or 3 Poles as required, NEMA 1 enclosure for surface mounting. Use only for motors with internal thermal overload protection.
- D. Magnetic Starters: Non-reversible line voltage type with thermal overload relays in each phase leg, auxiliary contacts of number required for control and interlock. Control power transformer, 50VA, 120 volt control power; hand-off-auto selector switch on all automatic control units neon type red "RUN" lights replaceable contacts, accessible without removing

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

wiring, 240 volt rated; reset push button, manual start-stop push button on units not under automatic control. Individual mounted starters shall have general duty NEMA 1 enclosure. Combination type starters shall have integral fused disconnect switch.

- E. Contactors: Same mechanism as used for magnetic starters, without overload protection.
- F. Control Devices: Pushbutton and selector switches shall be rated 10 amps at 120 V.A.C. momentary or maintained operation with number of contacts as indicated. Pilot lights shall be 6 V.A.C. transformer type, color as indicated. Equip all control devices with legend plate.
- G. All motor starting equipment shall be equal to products by Square D, G.E. or Cutler-Hammer.

2.11 Equipment Backboards

- A. All surface mounted equipment in electric and mechanical rooms shall be mounted on 3/4" plywood backboards install backboards on unistrut frames to provide an air space between the wall and backboard. Paint the backboards grey on both sides before installation.

2.12 Grounding and Bonding

- A. Furnish and install a complete grounding system in accordance with the National Electrical Code and special rules which may govern such installations and to the extent required for the work included in this specification.
- B. Flexible metal conduit and fittings not approved for ground bonding shall have bonding jumper.
- C. All equipment enclosures, motor frames conduit systems, cable armor, exposed structural steel and similar items shall be grounded.
- D. Conductors for grounding and bonding shall be copper, either bare or green insulated.
- E. Grounding connectors shall be clamp or pressure for exposed connections, compression or thermal weld type for buried connections.
- F. Contractor shall exercise care to ensure good ground continuity in particular, between conduit system and equipment frames and enclosures. Where necessary, jumper wire shall be installed.

2.13 Emergency Generator

- A. It is the intent of this specification to secure an emergency generator system that has been prototype tested, factory built, production tested, and site tested, of the latest commercial design, together with all accessories necessary for a complete installation as shown on the drawings and specified herein. The equipment supplied and installed shall meet the requirements of the National Electrical Code. NFPA-110, NFPA-99 (Type II) and all applicable local codes and regulations. All equipment shall be new, of current production by a national firm which manufactures the generator and controls, transfer switch, and assembles the generator set as a matched unit so that there is one-source responsibility for warranty, parts, and

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

service through a local representative with factory-trained servicemen. The installation shall meet all requirements of NFPA-110 for Level 1, Type 10, Class 48 emergency power supply systems.

- B. Submittals shall include specification sheets showing all standard and optional accessories to be supplied, schematic wiring diagrams, dimension drawings, and interconnection diagrams identifying by terminal number each required interconnection between the generator set, the transfer switch, and the remote annunciator panel.
- C. To assure that the equipment has been designed and built to the highest reliability and quality standards, the manufacturer shall {be responsible for design prototype tests as described herein: }[have conducted design prototype tests.] Components of the production emergency system, such as the engine/generator set, transfer switch, and accessories shall not be subjected to prototype tests since the tests are potentially damaging. Rather, similar design prototypes are reliability pre-production models, which will not be sold, shall be used for these tests. {Prototype test programs shall include the requirement of NFPA-110 and the following. }
[Certified test shall be submitted for the following:]
 - 1. Maximum power (kw).
 - 2. Maximum starting (kva) at 35% instantaneous voltage dip.
 - 3. Alternator temperature rise by embedded thermocouple and by resistance method per NEMA MG1-22.40 and 16.40.
 - 4. Governor speed regulation under steady-state and transient conditions.
 - 5. Voltage regulation and generator transient response.
 - 6. Fuel consumption at [no load,] 1/4, 1/2, 3/4, and full load.
 - 7. Harmonic analysis, voltage waveform deviation, and telephone influence factor.
 - 8. Three-phase line-to-line short circuit test.
 - 9. Alternator cooling air flow.
 - 10. Torsional analysis testing to verify that the generator set is free of harmful torsional stresses.
 - 11. Endurance testing.
- D. The emergency generator system shall be warranted by the manufacturer, with a comprehensive warantee, for five years, from the date of the site start-up. Parts and service shall be available from a factory authorized service center capable of responding to emergency service requests within 24 hours and to all service and repair requests within 48 hours.
- E. The standby generator set shall be rated continuous standby power production (defined as continuous for the duration of any outage) 120/208 volts, 3 phase, 4 wire, .8 powerfactor, 90 KW, 113 kva, 313 ampere at 3000 feet attitude, 100 degrees Fahrenheit, as KOHLER MODEL 100RZ with a 4S9 generator frame. Vibration isolators shall be provided between the engine-generator and welded steel base.
- F. Generator set shall be tested under varying loads with guards and exhaust system in place. Tests shall include; and certified reports shall be submitted for:
 - 1. Single-step load pickup.

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

2. Transient and steady-state governing.
3. Safety shutdown device testing.
4. Voltage regulation.
5. Rated Power. (100% output for 4 hours)
6. Maximum Power (110% output for 20 minutes)

G. After factory testing is complete, the generator shall be shipped to the nearest factory authorized service center where it shall be subjected to the tests specified in F above. The set shall then be disassembled into the fewest possible major components (engine, generator, base) that will permit the unit to be moved to the site and into the basement without exceeding the maximum loading of the existing first floor or width of available doors, corridors, ect. comprising the access route. The generator shall be re-assembled in the generator room and subjected to all tests specified in F above using [a resistor bank] {building electrical loads}. Certified reports for both of these tests shall be submitted.

*** or ***

H. After installation the generator set shall be subjected to all tests specified in F above using [a resistor bank] {building electrical loads}. Certified reports for both of these tests shall be submitted. The engineer shall be notified one week prior to testing so arrangements to witness the test can be made.

2.14 Engine

A. The 460 cubic inch displacement engine shall deliver a minimum of 168 hp at a governed speed of 1800 rpm. The engine shall be equipped with the following:

1. Fuel filters and electric solenoid fuel shut-off valve.
2. Gear driven governor capable of regulating the no load to full load frequency to a 5% maximum and capable of 0.66% Steady State frequency regulation.

*** or ***

3. Isochronous governor capable of .025% Steady State frequency regulation.
4. 12 volt positive engagement solenoid shift-starting motor.
5. 35-ampere minimum automatic battery charging alternator with solid-state voltage regulation.
6. Positive displacement, full pressure lubrication oil pump, cartridge oil filters, dipstick, and oil drain.
7. Dry-type replaceable air cleaner elements.
8. Gas pressure regulator.

(Note: Engines requiring glow plugs are not acceptable)

B. The naturally aspirated or turbocharged engine shall be fueled with L.P. gas, have 8 cylinders, 4-cycle, and be liquid cooled. A [remote]{unit}-mounted radiator, [suitable for outdoor mounting, sized in accordance with the engine supplier's recommendation shall properly cool the engine.

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

The radiator shall include an electric motor-driven fan, fan shroud, fan core guard, surge tank, and filter with pressure cap.]{ blower fan, water pump, and thermostat shall properly cool the engine with up to 0.5 inches H₂O external static pressure on the cooling system.}

2.15 Generator

- A. The alternator shall be salient-pole, reconnectable 12-lead, self-ventilated of drip-proof construction with amortisseur rotor windings and skewed [stator] for smooth voltage waveform. The insulation shall meet the NEMA standard MGI-22.1 and 16.40 for Class H and be vacuum impregnated with epoxy varnish to be fungus resistant per MIL I-24092 {or be multiply dipped and baked with nonhygroscopic varnish with a final dip of epoxy}. The excitation system shall be of brushless construction controlled by a solid-state voltage regulator {with adjustable Volts-per-hertz operation }capable of maintaining voltage within + or - 2% at any constant load from 0 to 100% of rating. The regulator shall be [protected from the environment by conformal coating.]{sealed from the environment and isolated from the load to prevent tracking when connected to SCR loads.}
- B. On application of any load up to the rated load, the instantaneous voltage dip shall not exceed 20% and shall recover to + or - 2% of rated voltage within one second.
- C. The generator shall be capable of sustaining at least 250% of rated current for at least 10 seconds under a 3 phase symmetrical short by inherent design or by the addition of an optional current boost system.
- D. The generator shall be capable of accepting the loads that were specified with 50 KVA, 50 KW being the largest running loads and 6% being the largest instantaneous voltage dip when loads are started as specified on the loads report.
- E. A resettable line current sensing circuit breaker with inverse time versus current response shall be furnished and shall not automatically reset preventing restoration of voltage if maintenance is being performed. This breaker shall protect the generator from damage due to its own high current capability and shall not trip within the 10 seconds specified above to allow selective tripping of down-stream fuses or circuit breakers under a fault condition.
- F. The generator, having a single maintenance free bearing, shall be directly connected to the flywheel housing with a semi-flexible coupling between the rotor and the flywheel.

2.16 Controller

- A. Set-mounted controller capable of facing right, left, or rear shall be vibration isolated on the generator enclosure. The microprocessor control board shall be {moister proof and capable of operation from -40°C to 85°C.}[conformal coated.] Relays will only be acceptable in high current circuits Circuitry shall be of plug-in design for quick replacement. Controller shall be equipped to accept a plug-in device capable of allowing maintenance personnel to test controller performance without operating the engine. The controller shall include:
 - 1. Fused DC circuits.

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

2. Complete two wire start/stop control which shall operate on closure of a remote contact.
3. Speed sensing and a second independent starter motor disengagement systems shall protect against the starter engaging with a moving flywheel. Battery charging alternator voltage will not be acceptable for this purpose.
4. The starting system shall be designed for restarting in the event of a false engine start, by permitting the engine to completely stop and then reengage the starter.
5. Cranking cyclus with 15 second ON and OFF cranking periods.
6. Over-crank protection designed to open the cranking circuit after 75 seconds if the engine fails to start.
7. Circuitry to shut down the engine when signal for high coolant temperature, low oil pressure, or over-speed are received.
8. Engine cool down timer factory set at five minutes to permit unloaded running of the standby set after transfer of the load to normal.
9. Three-position (Automatic - OFF - TEST) selector switch. In the test position, the engine shall start and run regardless of the position of the remote starting contacts. In the automatic position, the engine shall start when contacts in the remote control circuit close and stop five minutes after those contacts open. In the off position, the engine shall not start even though the remote start contacts close. This position shall also provide for immediate shutdown in case of an emergency. Reset of any fault lamp shall also be accomplished by putting the switch to the off position.
10. Indicating lights to signal:
 - a) Switch "{Not-in-Auto}{[OFF]}" (flashing red)
 - b) Over-crank (red)
 - c) Emergency stop (red)
 - d) High engine temperature (red)
 - e) Overspeed (red)
 - f) Low oil pressure (red)
 - g) {Battery charger malfunction}{[High battery voltage]} (red)
 - h) Low battery voltage (red)
 - i) Low fuel pressure (red)
 - j) System ready (green)
 - k) Anticipatory high water temperature (yellow)
 - l) Anticipatory low oil pressure (yellow)
 - m) Low coolant temperature (red)
11. Test button for indicating lights.

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

12. Alarm horn with silencer switch{ per NFPA-110}.
13. Terminals shall be provided for each signal in 10 above for connection to remote monitoring devices.

2.17 Instrument Panel

A. A set mounted instrument panel shall include:

1. Dual range voltmeter, 3 1/2 inch, + or - 2% accuracy.
2. Dual range ammeter, 3 1/2 inch + or - 2% accuracy.
3. Voltmeter-ammeter phase selector switch.
4. Lights to indicate high or low meter scale.
5. Direct reading pointer-type frequency meter, 3 1/2 inch, + or - 5% accuracy, 45 to 65 Hz scale.
6. Panel illuminating lights.
7. Battery charging meter.
8. Coolant temperature gauge.
9. Oil pressure gauge.
10. Running time meter.
11. Voltage adjust rheostat, + or - 5% range.

B. The following accessories shall be provided:

1. Block heater of proper wattage and voltage, thermostatically controlled to maintain engine coolant at 90 °F to meet the start-up requirement of NFPA-99 of NFPA-100 Regulations.
2. Over voltage protection will shut down the unit after one second of 15% or more overvoltage.
3. Battery rack, battery cables, 12-volt battery(ies) capable of delivering the minimum cold-cranking amps required at zero degrees Fahrenheit per SAE Standard J-537 shall be supplied dry, along with separate electrolyte, which will be added just prior to start-up. Provide battery certification per NFPA-110.
4. 10-Ampere automatic float battery charger with +/- 1% constant voltage regulation from no load to full load over +/- 10% AC input line variation, current limited during cranking operations and short circuit conditions, temperature compensated for ambients from -40°C to +60°C, 5% accuracy voltmeter and ammeter, fused, reverse polarity and transient protected. Optional alarm circuit board to meet the requirements of NFPA-110 for low battery voltage, high battery voltage, and battery charger malfunction.
5. Gas-proof, seamless, stainless steel, flexible, exhaust connection, and engine exhaust silencer with plugged or valved drain fitting rated for critical application. Coated to be temperature and rust resistant, rated for critical applications. Exhaust noise shall be limited to 85 dBa as measured at 10 feet in a freefield environment.

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

6. 16-light remote annunciator shall monitor all controller functions described in paragraph 2.16.A.10 above plus line power and generator power monitoring. An integral lamp test and horn silence switch shall be included that meets NFPA-110.
7. Flexible fuel line(s) rated 300°F and 100 psi ending in pipe thread.
- [8. Coolant hot well tank as shown on the plans with baked enamel paint finish over rust inhibiting coating.
9. Coolant circulator pump equal to Bell and Gossett Series 60, 1 HP, 208 volts, 3 phase, 47 GPM at 42 feet total head.
10. Break glass emergency OFF switch per NFPA-110 requirements.
11. Flexible coolant hoses at engine supply and return connections.
12. Exhaust pipe rain cap, hinged type for vertical pipe.]
13. Steel weather-protective enclosure with removable or hinged side panels to allow inspection and maintenance. The enclosure shall be coated with ASA grey primer and two coats of high-gloss, weather-proof, sag resistant vinylac in the manufacturer's standard color through an electrical bonding process. The specified exhaust silencer shall be vibration-mounted on the roof of the enclosure.

2.18 Automatic Transfer Switch*****

- A. Furnish and install at location shown on the Drawings an automatic transfer switch to protect load from loss of power. The switch shall include full phase protection and shall be rated 400 amperes, 208 volts (a.c.), 60 hertz, for use on a 3-phase, 4-wire system. The switch shall be suitable for all classes of load without derating, NEMA type 1 enclosure. The switch shall be Kohler Model K-168541-0400 with overlapping neutral contacts.
- B. On failure of normal power, or a drop in voltage on any phase to 70% of nominal, contacts shall close after an adjustable delay of 0.6-60 seconds to override momentary voltage fluctuations, and signal the engine generator to start. When the generator reaches 90% of rated voltage and frequency, the switch shall operate to transfer the load to generator. On restoration of all phases of normal power to 90% or more of nominal voltage for an adjustable period up to 30 minutes, the switch shall retransfer the load to normal and the engine-starting contacts shall open. Transfer in either direction between live sources shall occur when sources are in phase.
- C. The transfer switch shall be mechanically held contact device complete with terminal lugs suitable for copper or aluminum conductors. The contacts shall be operated by a common mechanism to provide double throw switching action.
- D. The transfer mechanism shall be electrically operated by a single unidirectional motor or solenoid mechanism, which shall be powered by the source to which the switch is transferring. The switch shall be mechanically and electrically interlocked so that no neutral position is possible during

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

automatic operation. The switch shall be capable of manual operation and shall have provision for disengaging the motor when so operated. It shall not be possible for the load to be simultaneously connected to the normal and emergency sources under manual or automatic operation. A neutral position shall be possible during manual operation to allow maintenance of load circuits. The speed of contact opening and closure shall be the same during manual and automatic operation.

- E. Switch shall have equal withstand, closing and interrupting ratings at the voltage employed, sufficient for the available short circuit current at the point of application. The withstand rating shall be 200,000 amperes asymmetrical when protected by current limiting fuses.
- F. The control circuits shall employ industrial type relays at 10 amperes with self-cleaning contacts. All control components and wiring shall be accessible from the panel for ease of maintenance.
- G. Each Transfer switch and accessories shall be enclosed in a NEMA 1 lockable steel enclosure with hinged door. It shall be U.L. 1008 listed, including accessories, and CSA listed. It shall include a test switch to simulate normal power failure, and include the following accessories:
 - 1. Time delay on engine starting, adjustable 0.6 to 60 seconds.
 - 2. Time delay emergency to normal power to permit stabilization of the normal power source before retransfer, adjustable 0.2 to 30 minutes.
 - 3. Frequency/voltage relay for emergency source to monitor one phase of standby source and prevent transfer from normal to emergency until the standby source has reached the relays preset values of voltage and/or frequency. Should the standby source vary beyond the relay limit setting it will initiate retransfer to normal.
 - 4. Test switch to test operation of the transfer switch simulate a power failure on the normal side.
 - 5. Pilot lights to indicate to which source the load connected.
 - 6. Auxiliary relay controls, four Form C (N.O./N.C.), wired to terminal blocks that will transfer when the relay is either energized or de-energized. One set of relays connected to normal source and one set of relays connected to standby source.
 - 7. In phase monitor to inhibit transfer in either direction unless normal and standby sources are in phase, capable of adjusting engine governor to obtain matching phase rotation and overridden if one source is not energized.
 - 8. Engine cool down timer, adjustable 1 to 30 minutes after transfer to normal.
 - 9. Programmable generator set exerciser clock, allowing selection of "day of week", and "time of day" exercising, for one to seven days per week, with option to transfer for exercising under load.

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

2.19 Exhaust and Coolant Piping Systems

- A. Piping for engine coolant system shall be schedule 40, black steel pipe, ASTM A-120. Fittings and joints shall be 150 lb. threaded.
- B. Generator exhaust piping shall be Schedule 40 wrought iron ASTM A-72 with malleable iron 150 lb. fittings.
- C. Valves: Except as otherwise indicated, provide factory-fabricated valves of the type, body material and pressure class indicated. Where type or body material is not indicated, provide proper selection as determined by Installer for installation requirements, with pressure class selected from MSS or ASTM standards based on the maximum pressure and temperature in the piping system. Except as otherwise indicated, provide valve size same as connecting pipe size.
1. Gate valves: Jenkins Figure 270, screwed ends, bronze body, 200 lb. W.O.G.
 2. Ball valves: Jenkins Fig. 32 A, screwed ends, bronze body, stainless steel ball, Teflon seat, 150 lb. Stm.
 3. Hose drains: Nibco-Scott, Fig. No. 74 drain for screwed connection, 1/2" I.P.S to 3/4" hose.
- D. Hangers and Supports: Provide sufficient hangers, supports, beam clamps, inserts, rods, rollers and devices required to support piping without sagging, and so located and arranged as to permit free expansion and contraction of piping. They shall be located near or at changes in piping direction and at concentrated loads, and provide vertical adjustment to maintain pitch required for proper drainage.
1. Hangers shall be constructed of malleable or wrought iron hangers supporting copper pipe shall be copperplated. Acceptable manufacturers are. Fee & Mason, Grinnell Co., Carpenter & Patterson. Provide the following types:

Pipe Size	Type	Fee & Mason No.	
Steel pipe:			
4" and larger	Adjustable roller	272	
2 1/2" and 3"	Adjustable clevis	239	
2" and smaller	Adjustable bank		232
Iron piping:			
4" and larger	Adjustable clevis	239	
3" and smaller	Adjustable band	232	

2. Horizontal piping shall be supported as follows:

Pipe Size	Rod Dia	Max. Spacing
-----------	---------	--------------

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

4" and larger	1/2"	10'
3" and smaller	3/8"	12'

3. Where groups of three or more pipes occur, they may be supported with trapeze hangers, using two hangers as specified, with a capped pipe cross member.
 4. For vertical piping, support steel and iron pipe at every floor with Fee & Mason No. 238 riser clamp.
 5. Pipe hangers shall be attached to the concrete, using Fee & Mason No. 187, concrete insert for loads up to 400 lbs. and Fee & Mason No. 185 universal concrete insert for loads up to 1,430 lbs. Use Fee & Mason No. 249 for attachment to steel.
 6. Pipe hangers for all insulated piping shall be large enough to encompass the insulation using a metal shield, so the insulation jacket will not be broken. Shields shall be 20 gauge galvanized steel minimum length 12".
- E. Pipe Sleeves: Provide sleeves to accommodate all pipes passing through foundations, walls, floors, furring and partitions. Cooperate with General Contractor in setting sleeves. Sleeves shall be full thickness of construction. Sleeves shall be large enough to accommodate insulation where required and of sufficient diameter to permit free movement of pipe where expansion and contraction occur. Sleeves through exterior walls below grade, or through foundation walls shall be watertight construction and shall be caulked with {oakum and lead wool}[elastomeric caulking] between sleeve and pipe on both sides of wall. Sleeves through concrete floors on grade shall be filled with graphite packing and caulking compound between sleeve and pipe.
- F. All engine coolant piping shall be insulated with 1/2" thick preformed Fiberglass equal to Owens-Corning Fiberglass with jacket with self-sealing laps and end joint butt strips. Insulation on cold water lines shall have vapor barrier. Fittings and valve bodies shall be covered with mitered ends, pre-molded fittings and hydraulic setting cement, wrapped with glass cloth and sealed with vapor barrier mastic. Insulation concealed in vertical chases shall be provided with aluminum holding bands, one at each joint strip and one in the center of each 3-foot section or 18-inch o.c. All exposed pipe insulation in mechanical rooms, storage rooms, etc. shall be wrapped with glass cloth applied with a fire-retardant mastic suitable for finish painting.
- G. All generator exhaust piping and the muffler shall be insulated with Owens-Corning "Kaylo-10" calcium silicate 1-1/2" thick, block type, 1,200 degree service rating. Apply over expanded metal thimble providing 1" air space between blocks, piping and muffler. Finish with two coats 1/4" thick (each coat) of cement plaster, final coat to be 50% white cement. Piping exterior to building need not be insulated.

PART 3 - EXECUTION

3.1 Wire, Cable and Connectors

- A. Pull conductors together where more than one is being installed in a raceway. Use pulling

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

compound or lubricant, when necessary; compound must not deteriorate conductor and insulation. Do not use a pulling means, including fish tape, cable or rope, which can damage the raceway.

- B. Keep conductor splices to a minimum. Install splices and tape which have equivalent-or-better mechanical strength and insulation as the conductor. Use splice and tap connectors which are compatible with the conductor material.
- C. Color-Coding:
1. Color-coding and neutral identification shall be as specified in N.E.C. 210-5 and N.E.C. 200-6, 7, 8, 9 and 10.
 2. Branch circuit color-coding shall be as follows:

A ph	-	Black
B ph	-	Red
C ph	-	Blue
N	-	White
G	-	Green or Bare
 3. This color-coding shall be carried throughout the system, each 2-wire circuit having phase wires of the color of the phase they connect to; likewise switch feeds, switched legs and travelers in 3-way and 4-way switch runs.
 4. Green shall be used for grounding conductors only and shall not be current-carrying.
- D. Schedule of Wiring Methods
1. Interior dry locations shall be individual conductors in EMT conduit.
 2. Exterior feeders and branch circuit shall be conductors in rigid steel or intermediate metal conduit.
 3. Use flexible metal conduit for all final connections to motor driven equipment. Use liquid-tight flexible conduit for exterior work and at generator.
- E. Sealing of Wiring Systems
1. Provide seals for underground wiring in accordance with N.E.C. 300-5.
 2. Provide fire rated seals equal to Dow-Corning or Thomas and Betts foam systems. Minimum locations of penetrations to be sealed are corridor walls, ceilings and floors.
- F. Branch circuits, in general, shall be as shown on the Drawings; "****HOT" legs may be combined with a common neutral.*** The common neutral shall never be combined with more than 2 "HOT" legs of opposite phases and for more than one combined circuit. In no case shall neutrals of lighting circuits be combined with other circuits unless so shown on the Drawings. Conductors

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

shall be the same size from panels to every outlet except where home runs have been increased for voltage drop. [Full sized neutrals, no shared neutrals.]

- G. Prepare cables and wires for splicing and terminating, by cutting and stripping covering armor, jacket and insulation properly to ensure a uniform and neat appearance where cables and wires are terminated.
- H. Trim cables and wires to be as short as practical and arrange routing to facilitate inspection, testing and maintenance
- I. Coordinate installation of electrical connections for equipment with equipment installation work.

3.2 Electrical Raceways

- A. Complete the installation of electrical raceways before starting installation of cables within raceways.
- B. Provide flexible conduit for motor connections, and for other electrical equipment connections where subjected to movements and vibration.
- C. Wherever possible, install horizontal raceway runs before water piping.
- D. Conduit sizes shall be as indicated on the plans and as required by N.E.C. for number and size of conductors installed, unless larger is called for. Minimum size to be 1/2 inch.***3/4
- E. Joints shall cut square and tapered for water-tightness, burrs reamed smooth. Couplings shall be drawn up tight.
- F. Bends or offsets shall be made with standard conduit ells or bends made with an approved bender without deforming the conduit or exceeding the radius of curvature specified in N.E.C. The number of bends per run shall conform to the N.E.C. limitations.
- G. Conduits shall be concealed in all finished areas of new construction. Expose conduits only in storage rooms, mechanical equipment rooms and similar spaces.
- H. Concealed conduit runs shall be set in a direct line with long sweep bends and offsets, insofar as building and other trades obstruction will allow. Exposed conduit run shall be run parallel to and at right angles to building lines. Runs shall be continuous from outlet to outlet, from outlet to cabinet, pull or junction boxes and shall be secured in all such equipment with double locknuts and bushings in a manner that positive grounding is obtained throughout the entire installation. Bushings shall be insulated type. Bushings on conduits 1 inch or larger shall be grounding type, connected to the cabinet with a #8 AWG copper conductor.
- I. Maintain a minimum of 6" clearance between conduits and hot piping.
- J. Install pull boxes in any run in excess of 100 feet or with more than three (3) 90 degree bends or equivalent.

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

- K. Leave #10 steel drag wire in all empty conduits.

3.3 Electrical Boxes and Fittings

- A. Pull boxes sized as specified in N.E.C. shall be installed as necessary.
- B. Roughing-in dimensions of electrically operated equipment shall be furnished by trades supplying and/or installing same. Set conduit and boxes for connecting to units only after receiving approved dimensions and after checking locations with contractors.
- C. Provide weatherproof outlets for interior and exterior locations exposed to weather or moisture exposure.
- D. Provide knockout closures to cap unused knockout holes where blanks have been removed.
- E. Locate boxes and conduit bodies and pull boxes so as to ensure accessibility of electrical wiring.
- F. Do not use round boxes where conduit must enter box through side of box, which could result in a difficult and insecure connection with a locknut or bushing on the rounded surface.
- G. Secure boxes rigidly to the substrate upon which they are being mounted, or solidly embed boxes in concrete or masonry.

3.4 Panelboards

- A. Panelboard cabinets shall be securely attached to building structure. Coordinate with General Contractor for blocking or other means of support.
- B. A neatly typed directory shall be provided and fastened to each circuit breaker panel cover in a suitable manner. Directories shall be labelled by room names meaningful to the Owner.

3.5 Safety and Disconnect Switches

- A. Install disconnect switches used with motor-driven appliances, and motors and controllers within sight of the controller position unless otherwise indicated.
- B. Provide NEMA 3R enclosures for all switches designated WP.

3.6 Pipe, and Fittings

- A. Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with a minimum of joints and couplings, but with adequate and accessible unions for dissambly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, with 1/16" misalignment tolerance.

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

- B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in the shortest route which does not obstruct usable space or block access for servicing the building and its equipment. Hold piping close to walls, overhead construction, columns and other structural and permanent-enclosure elements of the building; limit clearance to 0.5" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1.0" clearance outside insulation. Wherever possible in finished and occupied spaces, conceal piping from view, by locating in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions. Do not run piping through electrical equipment spaces and enclosures.
- C. Piping System Joints: Provide joints of the type indicated in each piping system as follows:
1. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
 2. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.
 3. Insulating (Dielectric) Unions: Comply with manufacturer's instructions for installing unions. Install unions in a manner which will prevent galvanic action and stop corrosion where the "joining of ferrous and non-ferrous is required.
- D. Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specific coatings (if any). Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.
- E. All pipe lines shall be blown or flushed clean before piping tests are applied. All piping shall be tested as herein specified. No portion of any piping system shall be covered, concealed, used or - made inaccessible for testing, inspection, repair, correction or replacement, until test thereof have been satisfactorily completed and approved. Minimum test period two (2) hours.
- F. The Contractor must schedule his testing operation to the progress of the project as a whole and correct all defects discovered during tests. Repeat the tests until all parts of the work have withstood them successfully. When the piping is presented for acceptance, all valve stem packings must be new and without leaks. The Contractor shall furnish all labor, material, and services for testing including testing plugs, pumps, and compressors. He shall make and remove all temporary piping connections required for the tests, and shall dispose of test water and all wastes after tests. He shall leave all work in good order, ready for full use.

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

- G. All piping systems and related equipment shall be subjected to a field hydrostatic test before insulation is applied. Tests of all systems shall be made in accordance with NFPA Standards and local codes. Testing may be done in sections to facilitate construction.
- H. Test all piping to 100 PSIG. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure.
- I. Repair piping systems sections which fail the required piping test, by disassembly and re-installation, using new material to the extent required to overcome leakage. Do not use stop-leak compounds, mastics or other temporary repair methods.

3.7 Valves

- A. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
- B. Install valves with stems pointed up, in the vertical position where possible, but in no case with stems pointed downward from a horizontal plane.
- C. Where insulation is indicated, install valves, arranged in the proper manner to receive insulation.

3.8 Hangers and Supports

- A. Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping, from other piping.
- B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
- C. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
- D. Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- E. Install hangers and supports to provide indicated pipe slopes.

3.9 Piping Insulation

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

- A. Install insulation products in accordance with the manufacturer's written instructions, and in accordance with recognized industry practices to ensure that the insulation serves its intended purpose.
- B. Install insulation on pipe systems subsequent, to testing and acceptance of tests.
- C. Install insulation materials with smooth and even surface. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete the run. Do not use cut pieces or scraps abutting each other.
- D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.
- E. Maintain integrity of vapor-barrier jackets on pipe insulation and protect to prevent puncture or other damage.
- F. Cover valves, flanges, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install, factory molded, precut or job fabricated units (at Installer's option) except where a specific form or type is indicated.
- G. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
- H. Install protective metal shields and insulated inserts wherever needed to prevent compression of insulation.
- I. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

3.10 Generator Set Installation

- A. Install generator set as indicated on the Drawings in strict accordance with the manufacturer's written instructions.
- B. Generator set components shall moved through the building using routes coordinated with and approved by the Owner. Maximum design loading of existing floor construction shall not be exceeded. Provide for removal of existing doors and frames if necessary to move generator components through existing openings. Repair all damage to existing building and finishes caused during movement of the generator components to the full satisfaction of the Owner.
- C. An installation check, startup, and building load test shall be performed by the manufacturer's local, factory trained service personnel. The Engineer, regular operators, and the maintenance staff shall be notified of the time and date of the site test. The tests shall include:
 - 1. Fuel, lubricating oil, battery and antifreeze shall be checked for conformity to the manufacturer's recommendations under the environmental conditions present and expected.

**DEPARTMENT OF BUILDINGS
AND GENERAL SERVICES**

2. Accessories that normally function while the set is standing by shall be checked prior to cranking the engine. This shall include: engine heaters, battery charger, strip heaters, remote annunciator, etc.
 3. Start-up under test mode to check for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage and phase rotation.
 4. Automatic start-up by means of simulated power outage to test remote-automatic starting, transfer of the load, and automatic shutdown. Prior to this test, all transfer switch timers shall be adjusted for proper systems coordination. Engine temperature, oil pressure and battery charge level along with generator voltage, amperes, and frequency shall be monitored throughout the test.
- D. Provide antifreeze as recommended by the generator set manufacturer so that freezing point of engine coolant is -40 to -20 degree Fahrenheit.

3.11 Testing and Cleaning

- A. Test all systems, in the presence of the Engineer and demonstrate freedom from shorts and grounds and proper operation of all switches and controls. Correct any defects noted during testing, and retest until proper operation is obtained. After testing, clean all equipment, touch-up paint all rusty, scratched or marred equipment, adjust and lubricate all mechanisms as required.
- B. Upon completion of installation of electrical grounding system, test ground resistance with ground resistance tester. Where tests show resistance to ground over 3 ohms, take appropriate action to reduce resistance to 3 ohms or less by driving additional rods and retest to demonstrate compliance. Submit copy of ground testing results to Engineer.
- C. Prior to energization all feeders shall have their insulation resistance tested using a 500 volt DC megger. Test results shall be recorded and submitted to the Engineer
- D. Upon completion of testing, all electrical equipment shall be cleaned, lubricated per manufacturers instructions and excess lubricant removed.

END OF SECTION 16620